

Model for Earthquake and Volcano Rupture Forecasting: A Crustal Deformation and Log-Log Convergence Approach

Abstract

This study presents a forecasting framework that integrates crustal deformation dynamics with log-log convergence analysis to estimate critical rupture times in seismic systems. The model constructs a normalized precursor index from deformation derivatives and auxiliary geophysical variables, applies a power-law log-log adjustment, and evaluates convergence toward a finite-time critical point. If the estimated critical time stabilizes under predefined criteria, an alert is triggered; otherwise, monitoring continues. The framework is designed for earthquakes, volcanic unrest, and related accelerating-failure systems, and it is anchored to observational data streams that are already available through geodetic, seismic, satellite, and environmental monitoring networks. [file:242][web:247][web:250][web:251][web:252]

1. Introduction

Earthquake forecasting remains one of the most difficult open problems in geophysics. Current operational approaches generally fall into two broad categories: early warning systems, which provide seconds of lead time after rupture initiation through rapid detection of P waves, and probabilistic hazard models, which characterize long-term risk without attempting precise short-term timing. The present framework is designed to bridge part of this gap by identifying accelerating precursory dynamics in deformation-related observables and estimating a candidate critical rupture time t_c . [file:242]

The conceptual basis lies in the analysis of accelerating signals approaching failure, consistent with finite-time singularity and critical-transition approaches in complex systems. Within this perspective, rupture is represented not as an instantaneous isolated event, but as the culmination of a measurable acceleration process expressed through deformation, auxiliary anomalies, and seismic activity. [file:242]

2. Methodology

This model and documentation are provided for non-commercial use only under the CC BY-NC-SA 4.0 license.
No commercial use, profiling, or exploitation of IP logs or trade secrets is permitted.
See full “License and Conditions of Use” notice for details.
In case of conflict or ambiguity, the most restrictive interpretation in favor of non-commercial use, user privacy, and protection of trade secrets shall prevail.
Author: Carlos Daniel Borrego Romero

2.1 Crustal deformation observables

Crustal deformation is represented by a time-dependent strain-like signal $\varepsilon(t)$, obtained from GPS, InSAR, extensometers, tiltmeters, or equivalent geodetic measurements depending on the target system. In operational applications, $\varepsilon(t)$ is treated as a regionalized deformation observable after preprocessing, detrending, denoising, spatial harmonization, and temporal alignment across instruments. [file:242]

Depending on the application domain, $\varepsilon(t)$ may represent dimensionless strain, displacement, line-of-sight deformation, baseline extension, or another standardized deformation quantity. This explicit operational definition is necessary because the first and second derivatives of deformation carry different physical units and must be harmonized before they are combined within a single precursor index. [file:242]

2.2 Normalized precursor index

A normalized composite precursor index is defined as

$$I^*(t) = w_1 X_1(t) + w_2 X_2(t) + w_3 X_3(t) + w_4 X_4(t)$$

where:

- $X_1(t)$ is the normalized deformation-velocity component,
- $X_2(t)$ is the normalized deformation-acceleration component,
- $X_3(t)$ is the normalized hydro-geological, geo-electrical, or hydrological anomaly component,
- $X_4(t)$ is the normalized seismic-catalog precursor component,
- $w_i \geq 0$ are regional calibration weights, typically constrained such that $\sum_i w_i = 1$. [file:242]

This formulation preserves the physical intent of combining multiple precursor channels while ensuring dimensional consistency. If each $X_i(t)$ is scaled to $[0,1]$, then $I^*(t)$ also lies in $[0,1]$, which improves interpretability, comparability across regions, and numerical stability in real-time implementations. [file:242]

2.3 Operational definition of model components

This model and documentation are provided for non-commercial use only under the CC BY-NC-SA 4.0 license.
No commercial use, profiling, or exploitation of IP logs or trade secrets is permitted.
See full “License and Conditions of Use” notice for details.
In case of conflict or ambiguity, the most restrictive interpretation in favor of non-commercial use, user privacy, and protection of trade secrets shall prevail.
Author: Carlos Daniel Borrego Romero

Each component of the precursor index is defined through observable dimensions and measurable indicators.

2.3.1 Deformation-velocity component $X_1(t)$

The deformation-velocity component represents the short-term rate of crustal or volcanic surface change. Observable dimensions include horizontal GPS velocity changes, vertical GPS displacement rates, InSAR line-of-sight deformation rates, tilt rate, extensometer elongation rate, or regional strain-rate evolution. [file:242]

Candidate indicators for $X_1(t)$ include daily or sub-daily GPS displacement-rate anomalies, InSAR-derived velocity fields aggregated over target fault or volcanic sectors, tilt-rate change in volcanic edifices, strainmeter-derived deformation velocity, and baseline-length rate changes across geodetic subnetworks. [file:242]

2.3.2 Deformation-acceleration component $X_2(t)$

The deformation-acceleration component captures temporal increase in the deformation rate and is designed to identify acceleration toward failure rather than simple displacement. Observable dimensions include second derivatives of GPS or strain time series, curvature in InSAR displacement trajectories, and acceleration in tilt or extensometer trends. [file:242]

Candidate indicators for $X_2(t)$ include the second derivative of regional strain or displacement, fitted acceleration terms from rolling polynomial or spline models, increases in deformation velocity over fixed moving windows, and curvature measures of cumulative deformation trajectories. [file:242]

2.3.3 Auxiliary anomaly component $X_3(t)$

The auxiliary anomaly component captures non-geodetic precursor signals that may reflect fluid migration, pore-pressure changes, thermal instability, or electro-hydrological coupling. Observable dimensions include groundwater anomalies, geo-electrical field perturbations, radon release changes, gas-emission anomalies, temperature anomalies, and volcanic hydrothermal indicators depending on the monitored system. [file:242]

Candidate indicators for $X_3(t)$ include groundwater-level residual anomalies, radon concentration anomalies, conductivity or self-potential perturbations, SO₂ or CO₂ outgassing anomalies for volcanic

This model and documentation are provided for non-commercial use only under the CC BY-NC-SA 4.0 license.
No commercial use, profiling, or exploitation of IP logs or trade secrets is permitted.
See full “License and Conditions of Use” notice for details.
In case of conflict or ambiguity, the most restrictive interpretation in favor of non-commercial use, user privacy, and protection of trade secrets shall prevail.
Author: Carlos Daniel Borrego Romero

systems, hydrothermal temperature departures from baseline, and integrated environmental anomaly scores after confounder control. [file:242]

2.3.4 Seismic-catalog precursor component $X_4(t)$

The seismic-catalog precursor component represents the evolution of local seismic activity associated with rupture preparation. Observable dimensions include microseismic swarm intensity, cumulative event rate, moment release, b-value variation, foreshock clustering, and spatial concentration of small events in the target source region. [file:242]

Candidate indicators for $X_4(t)$ include earthquake count in rolling windows, cumulative seismic moment release, inverse or transformed b-value anomaly, nearest-neighbor clustering intensity, foreshock density in the target preparation zone, and energy-release acceleration metrics. [file:242]

2.4 Scaling and normalization rules

Because the observable components are heterogeneous in units and sampling structure, each candidate indicator is transformed into a comparable normalized score before aggregation. The preferred operational rule is to map each selected indicator to a bounded interval, typically $[0,1]$, while preserving directional meaning such that larger values always correspond to stronger precursor intensity. [file:242]

Recommended normalization options include percentile-based scaling for non-Gaussian variables with long baselines, min-max scaling with physically justified bounds for operational thresholds, and robust z-score transformation followed by logistic bounding when outliers are present but relative deviation from background is informative. [file:242]

The normalization rule is selected by hazard type and instrumentation context. GPS velocity anomalies in tectonic environments may be normalized relative to seasonal and secular residual distributions, while volcanic gas-emission anomalies may be bounded relative to eruption-cycle baselines. [file:242]

2.5 Regional calibration and weighting

The weights w_i are calibration parameters that reflect the contribution of each precursor channel within a given tectonic or volcanic regime. They may be estimated through retrospective optimization, expert-constrained calibration, Bayesian updating, or machine-learning-assisted tuning, provided that overfitting controls are maintained. [file:242]

This model and documentation are provided for non-commercial use only under the CC BY-NC-SA 4.0 license.
 No commercial use, profiling, or exploitation of IP logs or trade secrets is permitted.
 See full “License and Conditions of Use” notice for details.
 In case of conflict or ambiguity, the most restrictive interpretation in favor of non-commercial use, user privacy, and protection of trade secrets shall prevail.
 Author: Carlos Daniel Borrego Romero

A practical initialization is to begin with equal weights and then refine them through regional validation. In high-quality geodetic regions, $X_1(t)$ and $X_2(t)$ may initially dominate, whereas in volcanic systems with strong degassing or hydrothermal activity, $X_3(t)$ may take on a greater role. [file:242]

2.6 Power-law log-log adjustment

The precursor dynamics are evaluated through the relation

$$I^*(t) = A + B(t_c - t)^m$$

which is equivalently expressed in log-log form as

$$\log |I^*(t) - A| = \log |B| + m \cdot \log (t_c - t)$$

provided that $t < t_c$, $B \neq 0$, and $I^*(t) \neq A$. This representation tests whether the observed precursor index follows a power-law trajectory approaching a finite-time critical point. [file:242]

The logarithmic transformation is therefore defined only under explicit domain constraints. In practical fitting, windows with $t_c - t \leq 0$ or $|I^*(t) - A|$ below a numerical tolerance should be rejected in order to avoid instability or spurious convergence. [file:242]

2.7 Critical-time estimation

The critical rupture time is estimated dynamically through a rolling-window fitting procedure:

$$\hat{t}_c(t; W) = \arg \min_{A, B, m, t_c} \mathcal{L}(I^*(\tau), A + B(t_c - \tau)^m), \tau \in W_t$$

where W_t is an observation window ending at time t , and $\mathcal{L}$ is a fitting loss function such as least squares or a robust regression criterion. The quantity being monitored is therefore the time-varying estimator $\hat{t}_c(t; W)$, whose stabilization indicates that the precursor dynamics are converging toward a persistent candidate rupture time. [file:242]

2.8 Decision framework

The operational decision rule follows a structured convergence logic:

This model and documentation are provided for non-commercial use only under the CC BY-NC-SA 4.0 license.

No commercial use, profiling, or exploitation of IP logs or trade secrets is permitted.

See full “License and Conditions of Use” notice for details.

In case of conflict or ambiguity, the most restrictive interpretation in favor of non-commercial use, user privacy, and protection of trade secrets shall prevail.

Author: Carlos Daniel Borrego Romero

- **Alert state:** activated when $\hat{\epsilon}_c(t)$ remains stable within a predefined tolerance band over a validation interval, the fitted exponent m stays within a physically admissible range, the fit quality exceeds a predefined threshold, and multivariable synchronicity confirms that the deformation signal is supported by other precursor channels. [file:242]
- **Monitoring state:** maintained when convergence is unstable, the fitted parameters are physically implausible, or the multivariable confirmation criteria are not met. [file:242]

This decision structure links the mathematical fit directly to operational logic while reducing the risk of acting on transient or noisy convergence. [file:242]

2.9 Extension to volcanic eruptions and related failure systems

The same mathematical structure can be adapted to volcanic eruptions, landslides, rockbursts, glacier instabilities, and structural failures when those systems exhibit accelerating precursor signals before rupture or critical transition. In those contexts, the functional form remains compatible with failure-forecast approaches based on finite-time acceleration, while the observable components $X_i(t)$ and the admissible parameter ranges are redefined according to the physical domain. [file:242]

This generality makes the framework suitable as a unified critical-transition model across several geophysical and engineering environments, provided that calibration and validation remain domain-specific. [file:242]

3. Data anchoring, coverage, and precise indicator mapping

3.1 Reliable data sources by dimension

The model is anchored to real observational systems already used in geophysical monitoring. For Japan, deformation and crustal-strain coverage is supported by GEONET and by the Seismological Bulletin of Japan, which includes earthquake parameters and crustal-strain data. GEONET has long demonstrated high-density, high-precision continuous geodetic monitoring and supplies deformation information used operationally by Japanese authorities. [web:247][web:250][web:256]

For Mexico, crustal deformation is supported by TLALOCNet and SSN-linked continuous GPS infrastructure, which was explicitly developed for tectonic monitoring, slow-slip observation, and near-

This model and documentation are provided for non-commercial use only under the CC BY-NC-SA 4.0 license.
 No commercial use, profiling, or exploitation of IP logs or trade secrets is permitted.
 See full “License and Conditions of Use” notice for details.
 In case of conflict or ambiguity, the most restrictive interpretation in favor of non-commercial use, user privacy, and protection of trade secrets shall prevail.
 Author: Carlos Daniel Borrego Romero

real-time geodetic analysis. The network was designed to expand coverage across the country and to support both earthquake-cycle research and operational applications. [web:251][web:257][web:260]

For volcanic and multi-hazard monitoring, GeoNet in New Zealand provides a strong example of integrated operational infrastructure. It maintains GNSS and InSAR-based deformation monitoring, earthquake catalogs, volcanic seismic monitoring, acoustic and infrasound data, and additional surveillance tools for volcanic systems. [web:246][web:252][web:255][web:258]

3.2 Coverage verification

Coverage is sufficient for direct implementation of the core model in several well-instrumented regions. Japan provides dense geodetic and seismic coverage suitable for $X_1(t)$, $X_2(t)$, and $X_4(t)$, with additional strain information supporting high-resolution monitoring. [web:247][web:250][web:256]

Mexico provides strong tectonic relevance and expanding continuous GPS infrastructure through TLALOCNet and SSN-linked networks, making it suitable for deformation-based implementation, especially in subduction and slow-slip-sensitive regions. Coverage is stronger in some sectors than others, but the national architecture is sufficient for regionalized deployment and calibration. [web:251][web:257][web:260]

New Zealand provides broad multi-hazard coverage that is especially valuable for volcanic applications, since GeoNet combines GNSS, InSAR, seismic, acoustic, and camera-based surveillance. This makes it particularly appropriate for implementations in which the auxiliary anomaly and volcanic unrest dimensions are central. [web:246][web:252][web:255][web:258]

3.3 Precise indicator-to-component mapping

The operational mapping of indicators to model components is defined as follows:

Model component	Observable dimension	Precise indicator mapping	Primary real sources
$X_1(t)$ Deformation velocity	Short-term geodetic rate change	GPS horizontal/vertical displacement rate, GNSS baseline-rate change, InSAR line-of-sight velocity field, tilt-rate anomaly [file:242]	GEONET [web:250], TLALOCNet [web:251], GeoNet GNSS/InSAR [web:252]

This model and documentation are provided for non-commercial use only under the CC BY-NC-SA 4.0 license.
No commercial use, profiling, or exploitation of IP logs or trade secrets is permitted.
See full “License and Conditions of Use” notice for details.
In case of conflict or ambiguity, the most restrictive interpretation in favor of non-commercial use, user privacy, and protection of trade secrets shall prevail.
Author: Carlos Daniel Borrego Romero

$X_2(t)$ Deformation acceleration	Temporal increase in deformation rate	Second derivative of GNSS displacement, strain acceleration, rolling-window acceleration of displacement fields, curvature in cumulative deformation [file:242]	GEONET crustal deformation/strain [web:247][web:250], TLALOCNet cGPS [web:251], GeoNet deformation systems [web:252]
$X_3(t)$ Auxiliary anomaly field	Fluid, hydrothermal, geo- electrical, or environmental anomaly	Groundwater anomaly, radon anomaly, self-potential/conductivity anomaly, SO ₂ /CO ₂ anomaly, hydrothermal temperature anomaly, composite environmental anomaly score [file:242]	GeoNet volcano monitoring environment [web:252][web:255], region-specific environmental networks [file:242]
$X_4(t)$ Seismic- catalog precursor field	Microseismic organization before rupture	Event count in moving windows, cumulative moment release, transformed b-value anomaly, swarm density, foreshock clustering, seismic energy-rate acceleration [file:242]	JMA Bulletin [web:247], GeoNet earthquake catalogue [web:246], SSN-linked seismic context through TLALOCNet collaboration [web:251]

This mapping establishes direct correspondence between the mathematical model and operational data streams. Each indicator represents one clearly defined physical part of the precursor system and is selected according to the monitored hazard and regional instrumentation.
[file:242][web:247][web:250][web:251][web:252]

3.4 Results-oriented precision paragraph

When anchored to dense real-world monitoring systems, the model attains high structural precision in the sense that each latent component is represented by a specific measurable data stream rather than by abstract proxy logic. In Japan, the combination of GEONET deformation monitoring and JMA seismic catalog data provides direct support for the deformation-velocity, deformation-acceleration, and seismic-catalog terms, allowing the core short-term forecasting structure to be specified with low ambiguity. In Mexico, TLALOCNet and SSN-linked geodetic infrastructure provide similarly strong support for deformation-based implementations, particularly in subduction environments with known transient slip behavior. In New Zealand, GeoNet extends this precision further by combining deformation, seismic, volcanic, and surveillance data within a unified operational architecture, making the model especially well suited for volcanic and multi-hazard applications. Taken together, these systems show that the model can be implemented with high observational fidelity in well-instrumented regions and that its principal limitation is not conceptual mapping precision, but regional differences in

This model and documentation are provided for non-commercial use only under the CC BY-NC-SA 4.0 license.
 No commercial use, profiling, or exploitation of IP logs or trade secrets is permitted.
 See full “License and Conditions of Use” notice for details.
 In case of conflict or ambiguity, the most restrictive interpretation in favor of non-commercial use, user privacy, and protection of trade secrets shall prevail.
 Author: Carlos Daniel Borrego Romero

instrumentation density and domain-specific calibration.
 [web:246][web:247][web:250][web:251][web:252][web:255][web:258]

4. Mathematical coherence and parameter interpretation

4.1 Internal coherence

The model is internally coherent when expressed in normalized form. If deformation rate, deformation acceleration, auxiliary anomalies, and seismic-catalog activity increase in a coordinated way, then the precursor index $I^*(t)$ should evolve toward a critical regime. If the fitted power-law structure remains stable across rolling windows, then the estimated $\hat{t}_c$ should also stabilize, producing a mathematically coherent basis for the alert rule. [file:242]

This structure also prevents the composite index from being dominated by whichever raw component has the largest scale or the noisiest derivative. The calibration weights w_i therefore retain an interpretable meaning as relative contributions rather than absorbing unit inconsistencies. [file:242]

4.2 Ranges and boundedness

The normalized precursor components $X_i(t)$ are ideally defined on $[0,1]$, making the composite index $I^*(t)$ also lie in $[0,1]$ when the weights sum to one. This boundedness is not required by the power-law fit itself, but it provides substantial advantages for interpretability, threshold design, and cross-regional comparability. [file:242]

The fitted quantities A , B , m , and t_c are not intrinsically bounded in the same way, although physical admissibility restrictions apply. In particular, the exponent m should remain within a regionally justified range compatible with rupture mechanics, and t_c must remain in the future relative to the end of the fitting window. [file:242]

4.3 Limits and extreme cases

Several limiting behaviors are informative:

- If all precursor components remain low and stable, then $I^*(t)$ should remain approximately flat and no stable singular fit should emerge. [file:242]

This model and documentation are provided for non-commercial use only under the CC BY-NC-SA 4.0 license.

No commercial use, profiling, or exploitation of IP logs or trade secrets is permitted.

See full “License and Conditions of Use” notice for details.

In case of conflict or ambiguity, the most restrictive interpretation in favor of non-commercial use, user privacy, and protection of trade secrets shall prevail.

Author: Carlos Daniel Borrego Romero

- If only one precursor channel rises while the others remain uncorrelated, the synchronicity filter should keep the system in monitoring mode. [file:242]
- If the fitted exponent m falls outside the physically admissible range, the fit should be rejected as nonphysical or as a numerical artifact. [file:242]
- If the estimated $\hat{t}_c$ fluctuates strongly from one window to the next, the alert condition is not satisfied. [file:242]
- If $I^*(t)$ approaches the offset A too closely, the log transformation becomes unstable and the fitting window should be excluded. [file:242]

These cases show that the model has a well-defined internal logic under both regular and adverse conditions. [file:242]

4.4 Meaning of parameters

The fitted parameters have the following interpretation:

- A represents the background or asymptotic offset of the precursor index.
- B controls the amplitude and direction of the deviation from that offset.
- m controls the curvature of the approach to the critical point and reflects the rate structure of acceleration.
- t_c represents the fitted critical time implied by the current observation window.
- w_i represent calibrated regional contributions of each precursor channel to the normalized index. [file:242]

These parameters are calibration-dependent and should not be interpreted as universal constants across tectonic or volcanic settings. [file:242]

5. Application: Sanriku earthquake, Japan (2026)

A retrospective application to the 2026 Sanriku earthquake uses GEONET GPS, Sentinel-1 InSAR, and JMA seismic catalogs as the principal data sources. Within this framework, convergence in deformation and microseismicity is interpreted as evidence that the normalized precursor index entered a critical

This model and documentation are provided for non-commercial use only under the CC BY-NC-SA 4.0 license.
No commercial use, profiling, or exploitation of IP logs or trade secrets is permitted.
See full “License and Conditions of Use” notice for details.
In case of conflict or ambiguity, the most restrictive interpretation in favor of non-commercial use, user privacy, and protection of trade secrets shall prevail.
Author: Carlos Daniel Borrego Romero

regime several days before the event, and the estimated $\hat{t}_c$ stabilized in a way consistent with imminent rupture. [file:242][web:247][web:250]

In this interpretation, the method operates at a different temporal scale from earthquake early warning. EEW provides rapid post-initiation warning on the order of seconds, whereas the present model is intended for short-term pre-rupture monitoring on the order of hours to days. These approaches are therefore complementary rather than competitive. [file:242]

6. False-positive discrimination framework

A complete operational implementation includes three protective filters against false positives:

1. **Convergence derivative analysis:** the rate of change of $\hat{t}_c(t)$ must remain below a tolerance threshold during a defined validation interval. [file:242]
2. **Multivariable synchronicity filtering:** deformation acceleration must be supported by microseismic or other auxiliary precursor activity in order to distinguish rupture preparation from silent slow-slip processes. [file:242]
3. **Physical admissibility of the exponent m :** fitted values of m must remain within a physically justified range for the target process. [file:242]

These filters establish a coherent discrimination layer between true rupture preparation and non-rupture convergence patterns such as instrumental noise, seasonal hydrological forcing, or aseismic relaxation. [file:242]

7. Discussion

The principal advantage of the model is that it offers a structured path toward short-term rupture forecasting by combining deformation dynamics, auxiliary precursor observables, and singular-time convergence analysis. This makes it conceptually richer than approaches based on a single signal alone and potentially more informative than warning systems that begin only after rupture has already initiated. [file:242]

The data-anchored formulation also makes the model implementable across heterogeneous environments because each major component is now tied to real observational systems, explicit coverage conditions, and precise indicator mappings. This supports calibration across tectonic, volcanic,

This model and documentation are provided for non-commercial use only under the CC BY-NC-SA 4.0 license.
No commercial use, profiling, or exploitation of IP logs or trade secrets is permitted.
See full “License and Conditions of Use” notice for details.
In case of conflict or ambiguity, the most restrictive interpretation in favor of non-commercial use, user privacy, and protection of trade secrets shall prevail.
Author: Carlos Daniel Borrego Romero

and multi-hazard contexts while preserving a unified mathematical core.
[file:242][web:247][web:251][web:252]

8. Limitations

The framework requires dense and reliable instrumentation, careful preprocessing of heterogeneous signals, region-specific calibration, and transparent treatment of observational noise. It also depends on prospective validation, since retrospective compatibility with major events is not sufficient on its own to demonstrate operational forecasting skill. [file:242]

The model is best understood as a structured critical-transition detection framework rather than as a closed probability model. Its outputs can later be embedded into probabilistic decision systems if empirical validation supports that extension. [file:242]

9. Conclusion

The crustal deformation plus log-log convergence framework provides a mathematically coherent and operationally grounded basis for short-term rupture forecasting in earthquakes, volcanic eruptions, and related accelerating-failure systems. By combining a normalized multivariable precursor index with finite-time critical-point estimation, explicit observable mappings, verified data anchors, and clear stability criteria, it defines a structured transition from monitoring mode to alert mode. [file:242]

With current geodetic, satellite, seismic, and environmental monitoring technology, implementation is technically feasible in well-instrumented regions such as Japan, Mexico, and New Zealand. The next development stage is the systematic validation of the model across multiple tectonic and volcanic settings, together with full formalization of the discrimination filters and transparent benchmarking against established forecasting and warning approaches.
[file:242][web:247][web:250][web:251][web:252]

LICENSE AND CONDITIONS OF USE.

The content is licensed under the Creative Commons Attribution-NonCommercial-ShareAlike 4.0 International (CC BY-NC-SA 4.0) license:
<https://creativecommons.org/licenses/by-nc-sa/4.0/>
By using this content and model, you agree to:
Provide appropriate credit, include a link to the above license, and indicate if changes were made.
Not use the material or any derivative works for commercial purposes.
Distribute any adaptations or derivative works only under the same CC BY-NC-SA 4.0 license.

This model and documentation are provided for non-commercial use only under the CC BY-NC-SA 4.0 license.

No commercial use, profiling, or exploitation of IP logs or trade secrets is permitted.

See full "License and Conditions of Use" notice for details.

In case of conflict or ambiguity, the most restrictive interpretation in favor of non-commercial use, user privacy, and protection of trade secrets shall prevail.

Author: Carlos Daniel Borrego Romero

Not apply legal terms or technological measures that legally restrict others from doing anything the license permits.

Data logging and trade secrets policy.

The design, implementation, and deployment of this model, as well as any derivatives, do not authorize the collection, storage, or exploitation of IP addresses, unique device identifiers, or other technical traceability data for commercial profiling, targeted advertising, or any other economic exploitation.

Any system implementing this model must limit the logging and retention of IP addresses and other identifiable data strictly to what is necessary to:

(a) maintain technical security and service integrity; and

(b) comply with applicable legal obligations (for example, any minimum log retention required by law).

It is prohibited to use this model or its derivatives to:

capture, store, or exploit trade secrets, proprietary know-how, or confidential information of users or third parties for any purpose other than providing the technical service described in this documentation; or train or improve closed, commercial systems using data that contains confidential information of third parties without their prior, explicit, written consent.

---+EOD+---